NORTH AMERICAN REVIEW.

No. CCCCLXXIV.

MAY, 1896.

THE ENGINEER IN NAVAL WARFARE.

BY COMMODORE GEORGE W. MELVILLE, ENGINEER-IN-CHIEF OF THE UNITED STATES NAVY; W. S. ALDRICH, PROFESSOR OF MECHANICAL ENGINEERING IN THE UNIVERSITY OF WEST VIRGINIA; IRA N. HOLLIS, PROFESSOR OF ENGINEERING IN HARVARD UNIVERSITY; GARDINER C. SIMS, OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS; AND GEORGE UHLER, PRESIDENT OF THE MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

I.

"*The naval supremacy of Great Britain rests in the hands of the engineers.* War rumors force such truths home, and they will be driven yet more forcibly home to the Admiralty before the year is out. Mr. Goschen (the First Lord of the Admiralty) *must* take steps to add to the number of engineers. Men cannot be had now, because the position and pay are not good enough. Is it too much to hope that the First Lord of the Admiralty will use his own eyes, and his own ears, and his own great common sense, and instead of allowing himself to be led by others, take the initiative, and, recognizing the importance of the naval engineer, place the profession on such a footing that entrance to its ranks may come to be sought for with eager anxiety?"

That great scientific periodical, *The Engineer*, of London, in its leader of February 7, 1896, thus startled the rulers of Britannia, and before the appeal had been read in the colonies of

Queen Victoria, the authorities had promised that reforms would be made in the relation of the engineering to the other branches of Her Majesty's Navy.

The same journal also declared that "while peace prevails it is possible for the Admiralty to pursue a policy of foolish economy" in trying to get along without a sufficiency of naval engineers; "but when war threatens—when, in fact, it is within measurable distance—any policy which endangers the national safety becomes criminal."

La Marine Francaise, in its issue of February 10, 1896, and speaking from a standpoint of loyalty to the sailor, affirms:

"Whether we like it or not, there is strife between the deck and the engineer officer. While the *rôle* of the former is growing less every day, that of the latter is constantly increasing in importance. Everything is engines in the Navy. We refuse to admit it, but strife does exist, and it is only when compelled and forced that we give the engineer due rank and authority. Formerly everybody *had* to be a sailor, now everybody *should* be an engineer."

The *Engineering News* of New York, of February 20, 1896, in a conservative editorial, declares that the demand for reorganizing the Engineer Corps of the United States "is probably not exceeded in importance with respect to our national defences by that of any measure which will come before Congress at this session." It further declares that:

"The existing demands of modern naval construction, maintenance, and tactics, are such that naval engineers, in order to proficiently perform all of the many duties demanded of them, ought to be the most highly-educated and scientifically-trained officers of the service. To say that any man loses caste socially by entering this branch of the naval service is silly and unworthy of a sailor. The work of the engineer officers in the creation of our new navy has called forth the heartiest praise from the experts of all nations; and anything that tends to deteriorate the quality of future graduates from the Naval Academy in the engineering branch cannot be swept away too soon."

Is it not significant that these representative technical papers of the three wealthiest and greatest manufacturing nations should publish such forcible and similar views within a few days of each other, although looking at the matter from different commercial, political, geographical, military, and national standpoints? It can only be accounted for by the fact that the military officials of these countries were suddenly aroused to the necessity of preparing a defence for a time of emergency. A careful study

of their respective naval organizations convinced experts that a spirit of caste and service traditions of mediæval origin had prevented the engineer from placing the modern battle-ship in a state of efficiency. The technical journals thus simply reflected the views of those who had this military and engineering problem to solve.

This is the age of the engineer, and he will be the great factor in modern warfare, whether the contest be waged by land or by sea. The rapidity with which the division of an army can be moved by mechanical means may decide the destiny of a nation. The skill of the mechanical engineer in mounting and protecting a gun, and in devising arrangements whereby it can be served and worked more readily, determines the value of the weapon whether it is placed in a fortress on shore, or in a turret on board a ship. The ability of the superintendents of our great industrial plants to provide munitions of war will be of more importance than the enrollment of brigades without rifles and cartridges.

The work of engineers like Bessemer and Siemens forced the construction of steel fleets. But the passing of ships of oak to make way for these vessels of steel should have been accompanied by corresponding changes in the organization of the crews. The requirements of a modern battle-ship are not founded upon the necessities of wooden frigates, and unless a radical change is made in the internal policy of our warships we invite a calamity in the day of battle.

The efficiency of the modern battle-ship, which is a series of separate compartments, must depend upon others besides the commander. It will be influenced by the endurance of the fireman behind the ram, that unseen stoker whose station is in front of the roaring furnaces. It may be determined by the skill of the machinist, who maintains in order the hydraulic gear connected with the gun mounting; for it will take but few weeks to train a man to sight a weapon and pull the lockstring, while it may require years to master the difficulties which are encountered on board ship in making hydraulic joints. The training of the men around the decks will be a simple matter compared with the organization of an efficient force in the engine and fire-rooms.

The trained engineer is a combatant in naval warfare,

for he is not only exposed to all the dangers from the ram and the torpedo, but also to the perils that confront him in managing the great boilers and engines. Is that man "a non combatant" who has the supervision of three sets of propelling engines, the management of a half dozen batteries of boilers and the maintenance of scores of auxiliary machines installed in places almost inaccessible for repairs but absolutely essential to the efficiency of the vessel?

Within the limits of a short article it is impossible to show the developments that have taken place. It is a certainty that the changes have resulted in the possession, by a warship, of three weapons—the gun, the ram, and speed. In the days of sail the vessel had one weapon only—the gun. It may surprise a layman to be told that speed is a weapon, but an element which permits the commander to seek or avoid a conflict, which allows him at will to move without the range of the enemy's guns, which will enable him to drive from the sea the commerce of his opponent, is a positive arm, and it is so regarded by all who have studied war as a science. *Speed, and particularly its control, is the cardinal element of tactics.* As the Earl of Hopetoun said a few weeks ago, in his presidential address before the Institution of Naval Architects, in London, "the weather-gauge of to-day is the power to out-steam the fleet of the enemy."

Ability to manœuvre is now more dependent upon the shape of the hull, and the number, form, and position of the propellers, than it is upon the skill of the most expert commander. With the advent of steam the possibilities of the warship vastly increased. As each successive auxiliary was installed the potency of the vessel was augmented, particularly when these machines were placed in the charge of trained men who were able to maintain them in a state of efficiency.

Steering engines and twin screws have improved the manœuvring qualities of vessels, and thus increased the offensive power of warships. No comparison can be made between the tactical possibilities of steam vessels and the sailing craft of a former decade. The engineer's work has determined absolutely the tactical diameter of the vessel, and when this is once established, the commander can secure it at will, for it is simply a question of using sufficient engine power to secure a given speed. In ancient days, skill in seamanship regulated the tactical diameter of the brig,

and as a result victories were won by the way in which the sails were handled.

The change in our warships will necessitate the development of one talent which was not so essential to the commander of the sailing craft. That quality is "nerve" and absolute reliance upon others. Inclosed in the conning tower, the commander will be dependent to a remarkable degree upon his chief engineer. Fortunately for the good of the service, the engineer in the day of battle will not be told how to manage the motive machinery by a trinity of men claiming to be vested with supreme authority. The captain of the vessel will be compelled to depend upon the ability of the engineers. The master of an old ship-of-the-line had a better knowledge of his crew than the commander of a modern battleship possesses of the feelings and resources of the men below the protective deck and of the efficiency of the machines under their charge. The capable commander will be as much concerned about disablements within the vessel as he will fear shots from without. In times past an inspiring act might revive the courage of depressed crews, but something more than courage will be required to secure efficiency from impaired machines.

The training of a Naval Engineering Reserve of officers is an important military question, and the scientific institutions of the country have a duty to perform in this matter. I have noted the work of engineer officers taken into our naval service by the many methods attempted. It has been my pleasure to have been associated with nearly every strong man who has been a member of the Corps of Naval Engineers. Friends like Isherwood, Haswell, and Copeland were among the officers who designed the excellent machinery of the ships of the Civil War. My contemporaries are the chief engineers of battle-ships like the "Indiana," and they have most efficiently supervised the construction of these vessels. Nearly all my assistants have been engineer graduates of the Naval Academy, under the system which obtained prior to 1882, when cadets were specially entered for the Engineer Corps. Advantages have thus been given me to study the question of how our naval engineering *personnel* should be educated. It is imperative that they receive military training, but the safety of our fleets demands that all should obtain more engineering instruction than is now given at the Naval Academy, where the cadets

assigned to the Engineer Corps are given but one year in marine engineering. The co-operation of the many scientific colleges and schools should be secured without delay.

The institution at Annapolis must be brought into competition with the scientific colleges. This policy would be of advantage to the cadets, to the competing institutions, and to the navy. Annapolis is either unable or unwilling to train naval engineers, and if its work is brought into comparison with that of other institutions, the Naval Academy will be compelled to extend its engineering curriculum or show cause for its existence.

The naval engineer has attempted to use industrial methods in the design, construction, and management of the machinery of our warships. He has urged that the military routine, which may be necessary for a marine guard, cannot be applied to the management of the fire-room force. He has been thwarted in his laudable efforts to reform the service by the words "strategy" and "tactics." Improvements proposed by him are said to interfere with the tactical rules that have been handed down from previous centuries. A policy suggested by the engineer is declared not in harmony with the strategy of naval warfare. His future usefulness thus compelled the engineer to give some consideration to the study of war. It was not long before he learned that strategy was a science, and tactics a very simple art which often related to routine duties that could be acquired by the drill sergeant. The Commander-in-Chief of the English army declares that any competent captain of a company can teach tactics to his subordinates.

Strategy is a science. It has been defined as: "The work and genius in the accomplishment of a military design." The engineer soon discovered that his work was of importance in the accomplishment of naval designs. In designing propellers, in shaping the hull, in controlling the power which will determine the efficiency of the gun mount, in providing reliable steering engines, in planning ventilating systems which will always be serviceable, in arranging a forced draft system which will be useful in emergencies, and in accurately placing about fifty miles of piping and seven hundred valves which are required on board a modern battle-ship, the engineer realizes that the strategic possibilities of a modern fleet of battle-ships are greatly dependent upon his thought and handiwork. He knows that strategy is important, but he

knows all strategy will fail which does not recognize the fact that success will be dependent upon the efficiency of the machines as well as upon the courage of the few men around the guns.

The engineer's work is carried on in a vitiated atmosphere, in cramped quarters, and he will be subjected to a strain whose intensity can only be realized by those who have taken part in a full powered trial of a modern cruiser. The successful torpedo boat builder of England, Mr. Thornycroft, says :

"In making the tour of his department, the chief engineer will find that the beat of the propelling engines will be confused by the addition of a number of auxiliary appliances, each adding its own peculiar series of sounds to the din and confusion of the roaring steam and the rush of water. This discord will be further complicated by the fact that the auxiliary machines in their rate of working keep no constant ratio to each other or to the main engines. The sense of feeling will have to be exercised, for the changes of temperature which may disable the auxiliaries can only be detected at times by touch. The eye is even put to a great disadvantage, for the motion of the reciprocating parts will be so rapid that no particular position of any working portion can be assigned to it. With a spray of water and oil thrown in their eyes, all those below will have their vision temporarily impaired."

While undergoing this ordeal, the engineer must have a clear mind for directing repairs, avoiding accidents, overcoming casualties and arranging stations. He must be cool in emergency, ready in resource, and possess physical and moral courage of high degree.

The artificers, engine drivers, warrant machinists, call them what you please, will have a light burden in battle compared with the trained engineer. This officer will have to supervise all the machinery below the water line. When the ship is cleared for action he must inspire that isolated band of firemen and mechanics hermetically sealed below the protective deck. Looking, therefore, to the engineer for instruction, for direction, for advice in emergency, and for support in danger, will be that body of unappreciated men who constitute his force.

The physical history of the Engineer Corps for the past five years has been impressively told by the Surgeon General of the United States Navy, and shows conclusively that men cannot endure this work for a protracted period. Those in charge of the machinery of an ocean greyhound or modern battle-ship will have but a short official life, and it behooves this nation to prepare a powerful engineering reserve for future needs.

In building battle-ships without providing for a trained and

sufficient corps of naval engineers, there is a royal road to disaster and defeat. There is a path to victory by recognizing the fact that the advent of the engineer, with his industrial methods, is a direct gain to the efficiency and glory of the naval service.

If the engineer is not worthy of official recognition, and of some of the emoluments of the naval service, as he stands in that magazine of death, with clear brain and steadfast courage, holding in his firm grasp the heartstrings of the ship, then a new lexicon is required to define his worth. If he falls beneath a maze of wrecked machinery, or within a blast of scalding steam, or sinks to ocean depths in the closed compartment, either he dies as heroes die, and his career has been honorable, or the world's ideal needs revision.

GEO. W. MELVILLE.

II.

SUCCESS in naval warfare is often developed out of conditions over which it has no control. Usually such conditions mark the epoch and form the distinguishing characteristics of the period. From the trireme to the "Minneapolis" was a great stride. There was only one intermediate step, however, and that through the epoch of sail power, if we accept the following dictum of one of the ablest tacticians of the new navy :

"The object of all manœuvres in action is to get and keep the enemy within effective range; to blank some of his fire by getting a superior position; to hold an advantage gained, or, losing it, to manœuvre for a fresh one; to concentrate fire on an exposed flank of the enemy in order to reduce the tactical efficiency of all his ships by crippling one or more."

These great principles are eternal. They were as applicable over two thousand years ago with oars as motive power, as in the days of the "Constitution" and "Guerriere," or in the more recent naval battle of the Yalu. What then has changed? Simply the motive power and the method of handling it, as called into requisition in carrying out the formulated principles of naval tactics. We are not now discussing the evolution of the weapons of offence and defence, nor the possible minute changes in naval tactics wrought by the developments of ordnance. Whether attacking with arrows or with shot and shell, the one thing needful is "to avoid waste of ammunition; but, of all things to keep up an effective and destructive fire."

Singularly enough history is repeating itself in naval tactics.

Steam power permits of massed formations, if the units can manœuvre adroitly together, even as in the days of the trireme. In fact, this is the distinguishing characteristic by which modern tactics differ from those of sailing days. But what a transformation meanwhile! And with it the passing of the sailor and the advent of the engineer! We shall not stop to discuss whether he has come to stay. As long as he can obtain coal, oil, or some other source of motive power than the capricious winds, there shall not be stretched another stitch of canvas on any naval vessel.

Steel warships are now propelled by engines of over twenty thousand horse-power and costing over one million dollars. In almost innumerable compartments are placed the auxiliary machinery and accessories. The ship is lighted by electricity, heated by steam, cooled by compressed air, and steered by hydraulic power. These four great agencies are also used for all sorts and conditions of service, capable at any moment of being called into operation by "pressing the button" on deck, while the engineer below deck does the rest. Passing from compartment to compartment one is almost lost in the bewildering maze of complicated machinery, demanded not alone for the propulsion of the ship, but for operation of the hoists, guns, steering gear, heating, lighting, and ventilating systems, and for the internal organization and management of what has not inaptly been termed "the engineers' ship."

This transformation has brought about conditions which must be fulfilled if all of this machinery is to be obtained of the best type and maintained in the highest state of efficiency. Engineering research is the new instrument of service in the hands of the engineer. Without some attention to it, present developments had been impossible. Without systematic work along these lines in the future, failure in naval warfare is a foregone conclusion.

In selecting the mechanical, electrical, hydraulic and compressed-air machinery used on board naval vessels, the questions of first cost and of yearly maintenance are vitally dependent upon being able to pre-determine its economical performance. Such machinery can only be operated most economically while cruising by making use of the latest experimental results along these lines The warship in commission is no place in which

to try such experiments. Repeated failures have occurred to many appliances which have been placed on these vessels simply upon the recommendation of the manufacturers or of others interested.

Preliminary experimental work would cost a trifle compared to the present yearly outlays of the government for the maintenance of the uneconomical machinery, auxiliaries and accessories on board several of our modern men-of-war. Very few of these have had their performance pre-determined. Such information cannot be obtained by the navy from private corporations and manufacturing establishments. The gravity of the situation respecting the value of naval engineering research is fully recognized in England. *Engineering*, of London, remarks:

"A private contractor works for private gain. The results of his experiments are as much his capital and property as the tools in his shop or the balance he may have at the bank. In the case of the navy it is the public that pays; and it is the public that has a right to know its money is not wasted."

The private establishments of our country may lead the world and be able to furnish the navy all the material it needs; but it is a fact only too well-known that of all purchasers the government can obtain the least information concerning the materials, mechanism and machinery it is about to install on its war vessels. Such engineering data and information must be obtained by the government, through the navy, at its own expense and for its own use.

Engineering research is now demanded by the exigencies of business, the keen competition of trade and the development of industry. The large manufacturing establishments, railroads and steamship companies have their testing departments or experimental staff to inspect their purchased supplies quite as much as to test their own manufactured products. Several British steamers of late construction have incorporated many minor improvements suggested by researches made by the engineers of their company. Along this line, *Engineering*, of London, takes occasion to remark:

"Our great shipping firms have long recognized that they can only maintain their national supremacy as the carriers of the world by reducing their 'running expenses' to the lowest possible minimum. . . . Some firms have allowed and encouraged their engineers to prosecute scientific research. . . . The various questions are treated not only scientifically,

but as they affect the owner's pocket, for this, after all, is the ultimate factor in problems in marine engineering. . . . The whole question of marine engineering testing and research has assumed a national importance of the most pressing nature. . . . The results of Admiralty trials leave much to be desired: many practical points are either omitted, or are given in an incomplete form."

Speed trials, builders' trials, contract trials, coal endurance trials, and "Admiralty" trials are all adapted to furnish just such information as they are designed to supply, and no more. The trend of modern engineering development is along inductive rather than deductive lines. The great achievements of engineering now witnessed on every hand are very largely due to the progressive and systematic development of research.

Foreign governments have long recognized the value of experimental work as directly affecting the efficiency of their naval establishments. England has a thoroughly equipped and organized chemical testing laboratory at Greenwich. At the Kiel navy yard, of the German Government, double-ended marine boilers are tested under all the conditions under which they are ever likely to be used on board ship; and while being thoroughly tested before going into the ship, every opportunity is afforded to note defects and remedy them. In France, Italy and Russia most elaborate experiments have been carried on by individuals, boards and specially-appointed committees, for the promotion of Naval Engineering progress. In a former article we pointed out the great value of the French Government experiments, in 1884-5, on the specially-fitted triple-screw steam launch "Carpe," as warranting the introduction of this system of propulsion for the new cruisers "Columbia" and "Minneapolis."

The problems of the naval engineer are essentially dynamic. They admit of the most intelligent solution only by the use of experimental data and the pre-determination of similar problems, investigated on a small scale, as in the case of the triple-screw experiments of the "Carpe." With the larger questions of marine engineering involved, such problems are quite beyond the range of private research.

Much valuable work has been done by individuals, such as Froude, Yarrow, Russell, and Marchal, for foreign navies, as well as by the research committees of technical societies, such as that on Marine Engine and Boiler Trials of the British Institution of Mechanical Engineers. In our own country, Isherwood,

Loring, Emery, Thurston, and others among our naval and ex-naval engineers, as well as Government Experiment Boards, have rendered like valuable services.

The problems of to-day are without precedent. Research must be made a business and not a passing pleasure. Organized efforts are now an absolute necessity to cope with the difficulties, bear the expense and successfully prosecute the experimental work now demanded by engineering in general and by naval engineering in particular. There is a growing recognition of the fact that the most efficient work can be done and the most satisfactory results obtained with a permanently located equipment in naval engineering experiment stations, with thoroughly organized staff working with clearly defined objects in view.

The efficiency of the machinery of the cruiser, ram or battleship involves such problems as can be best satisfactorily settled in an experiment station. In no other field of professional work can research and investigation yield such fruitful results and so greatly increase the efficiency of the United States Navy as in this one of engineering. The intelligent design of the mechanism, motive-power machinery and accessories of naval vessels is being more and more based upon the results of tests, trials, researches and scientific investigations.

At the Naval Engineering Experiment Station which it is now proposed to establish and maintain at New London, Connecticut, various engineering problems would be investigated on a small scale, similar to those long carried on by foreign governments, to obtain data for the intelligent solution of the larger problems of naval engineering design. New appliances would be thoroughly tested that they might be rejected if found wanting in efficiency and economy. New methods would be subjected to searching investigation. There would be thus secured for the naval service the very best materials and the highest types of motive-power and other machinery and accessories for warships and other naval vessels. Only in this way can our navy maintain any supremacy which it may now seem to have in the intelligence and skill of its engineering department.

Experimental engineering is capable of rendering the most valuable assistance in building up the new navy and maintaining the same in the most efficient condition. Future progress will be slow and will be attended with great risks and frequent fail-

ures if the United States navy does not recognize the efforts, now being made in all branches of marine engineering, to improve older types and present forms of the several varieties of mechanism, auxiliary and motive power machinery.

Federal aid for the promotion of engineering research in the several States has not yet received the recognition accorded to agricultural science by the Hatch act, of 1887.

During the past few years there has been growing a belief that every State College and University which is a beneficiary of the Land Grant bill, of 1862, and the Morrill act, of 1890, should receive a new national endowment. This should be devoted exclusively to the establishment, equipment and yearly maintenance of State Engineering Experiment Stations. The relation of these to engineering education and scientific investigation, to the diffusion of practical information among the people and the industrial development of each State, would be analogous to that now borne by the several State Agricultural Experiment Stations to agricultural science. Moreover, advisory and co-operative relations with government are vital to the mutual advantage of the government and the cause of each State's industrial development. In much the same way that the agricultural stations have established such relations by and through the Department of Agriculture, it is proposed that the engineering stations shall establish similar relations by and through the Department of the Navy.

The several State Engineering Experiment Stations will form invaluable aids to the government and materially assist its prosecution of scientific investigation and engineering research for the best interests of its naval service. These stations will afford facilities for post-graduate work and research to properly accredited graduates of technological schools, as well as the detail of naval engineers which the government may direct for such purpose. Being located in the several States they will be able to enlist the co-operation of builders, manufacturers and industrial establishments in the prosecution of such experimental engineering work as will secure to the government the best materials and the highest types of motive power and other machinery and accessories for warships and other naval vessels. The Secretary of the Navy may indicate from time to time such lines of inquiry and research as shall seem most important to the government,

and which may be most advantageously carried on in some one particular State.

Many engineering students in the Land Grant or federally-endowed institutions, receive military training and instruction. This makes possible an organization and development of combined engineering education and military training along such lines as have been worked out at the naval and military academies. The State colleges and universities, therefore, which are in some official way connected with the federal government and receive the national grants of money on condition of providing for such military instruction may become valuable agencies in supplying trained engineers should they come to be recognized as proper fitting schools for the government's naval service by Civil Service examination and appointment. The present co-operation of government with the States in engineering education and the proposed co-operation in engineering experiment, similar to that now existing for agricultural education and research, will strengthen and elevate the standard of engineering education, form powerful factors in the development of the industries and natural resources of the several States, and be of mutual advantage to the naval service and to the general government.

WM. S. ALDRICH.

III.

IT is strange in a country so democratic as the United States to find the engineer making a plea for recognition. His work and influence have been more potent than the efforts of the statesman in forming our Republic. The inventors of the steam engine and the steel rail have done more to weld together the parts of the continent than the signers of the Declaration of Independence, and the influence of James Watt is likely to survive all changes of governmental forms. In 1819, when England was struggling with vast economic problems, and when the steam engine and mechanical appliances were still in their infancy, Lord Jeffrey wrote of Watt and his inventions:

"It would be difficult to estimate the value of the benefits which these inventions have conferred upon this country. There is no branch of industry that has not been indebted to them; and, in all the most material, they have not only widened most magnificently the field of its exertions, but multiplied a thousand fold the amount of its productions. It is our improved steam engine that has fought the battles of Europe, and exalted and sus-

tained, through the late tremendous contest, the political greatness of our land. It is the same great power which now enables us to pay the interest of our debt and to maintain the arduous struggle in which we are still engaged."

If this was true in the days of Nelson and Wellington, how much truer it is in our day and in our country. The history of the world contains few influences which have entered so fully into the lives of a people as the mechanical appliances which have had their origin in the steam engine, and nowhere else have these appliances worked greater changes than in the means of transportation. Instead of the lumbering stage coach, we have the limited express; instead of the sailing clipper, the ocean "greyhound." Our warships have felt this quickening. The death-blow of the old system of sails and wooden hulls was struck when the ram of the "Merrimac" entered the hull of the "Cumberland." Since then our ships have changed to steel, and the sails have made way for steam. No government would dream now of putting sails on an ironclad. Few modern cruisers are fitted with them. The warships have become great workshops. The "New York" contains seventy-three engines and pumps, and the "Columbia" ninety-four.

We know well that within the last generation the engineer has advanced greatly in social and business consideration in civil life, that schools have been founded all over the country for his education and training, and that he bids fair within the next generation to take his rightful place as an acknowledged leader in all that concerns the material welfare of the human race.

It is well, then, to inquire how he has fared in the service of the government and what rewards he has there found under these changing conditions. In 1865, after the experience of a long war, the numbers of line or executive officers and engineers on the list of regulars in the navy were about equal, being 493 and 474, respectively, including all grades; in 1864, there were 2,846 line officers and 1,728 engineers, including volunteers; in 1896, after a complete transformation into a steam navy, there are 775 officers of the line and 198 officers of the engineer corps. The duties of the engineer have grown more important and multifarious, as the number of engineers has decreased and the number of his commanding officers has become greater. During this period, there has been a growing struggle between

the engineers and the group of line officers surrounding the Secretary of the Navy, so that now all legislation looking towards that change of system made necessary by the advent of machinery is effectually checked. The engineers have become discontented and unhappy in their official relations and our ships have lost largely in their effectiveness. Congress has received dozens of memorials urging that the educated engineer is an unnecessary factor on our ships and that it is the practical mechanic who is needed. This mechanic is expected to enlist, to sleep in a hammock and to be content with a maximum pay of seventy dollars per month. The engineer's force, from one-fourth to one-half of the whole crew, is to be in charge of one commissioned engineer officer. These memorials invariably insist upon having highly educated men at the helm and at the guns. Congressmen may not be well informed on naval affairs, but they are not devoid of common sense and this distinction between the two classes of officers is difficult to make clear. As a matter of fact, any of the duties on board of a man-of-war can be learned in course of time by any American citizen of average intelligence and fair education, even though he is not graduated from the Naval School or a College. The main object of education, therefore, is to enable a young officer to learn his profession more quickly, to endow him with a higher sense of duty, and, perhaps, to introduce into our ships the liberalizing and refining influence of culture so necessary to men who for long periods live together cooped up in a small cabin ; but this applies alike to engineers and deck officers.

We have heard much about our splendid *personnel*, and yet the stress of war would force us quickly into a complete change of system, both in administrative matters connected with the office of the Navy Department and the methods on board ships. There is scarcely a ship in commission to-day which is run with a due sense of economy to the government.

We read in the reports of the Secretary of the Navy that the line, or executive branch, is suffering from lack of promotion and that prompt measures must be taken in Congress to restore the efficiency of the corps by increasing the numbers in the "command grades"; not a word about the change which has actually taken place, that sails have disappeared, and with them a large element of the responsibility of the sailor. We have never had a

Secretary who has had an insight into mechanical and technical matters. They have been lawyers, no doubt actuated by patriotic and fair-minded motives, hampered by too great a sense of the legal status of every question, and too often forgetting that a new ship may become a source of disaster, instead of a prop, to the country if her crew is not organized to meet all requirements of modern science.

There is no doubt that naval officers, both line and engineer, are actuated by a sincere desire to promote the interests of the country and to make our new ships successful in peace and war. We find, however, that the traditions and discipline of a military system too often blind the sense and enthrall the conscience of even the wisest and best of men. It may have been for this reason that our ancestors dreaded the effect of a permanent military force upon this Republic. We are suffering to-day from the effects of tradition continued from the days of sails; and the commanding officers educated when steam was auxiliary rarely comprehend the duties of the engineer, or the responsibilities of his position. As an instance of this we have in the navy regulations a fiction that any line officer in charge of the deck represents the captain, and must, therefore, have the right to interfere with everything on board ship. This is a survival from the days when the propelling power was sails and everything was in sight of the watch officer, to the time when the ship is a huge mass of machines and nearly everything is out of his sight. It has been a cause of much soreness, as it has served to multiply the number of commanding officers on board our ships beyond the patience and endurance of the engineer. In the controversy which has resulted, there has never been a hint from the engineer against the authority of the commanding officer or the prompt obedience to a signal from the bridge, even if that signal be made by the powder boy; but he, nevertheless, feels that he has been defrauded of proper consideration, that his corps has been cut down without reason, and that he has never been allowed to develop, unhampered, the highest efficiency which can be obtained in our ships.

The attitude of the line officers may be gathered from a few extracts taken from a paper, prepared in 1888 for a line committee, by Lieutenant S. A. Staunton, and presented to Congress:

"The line officers of the Navy are the military branch. They carry out all executive and responsible duties in ships and squadrons, and are respon-

sible to the country for their preparation and readiness for action. His (a line officer's) training is purely military, and in his early manhood he finds himself fitted for nothing but a naval career. A naval engineer occupies a place radically different. All that is demanded from him is fair knowledge and skill and careful performance of duty. Engineers in the navy have at no time the responsibility of independent judgment which at any moment may fall upon the officer of the watch when in an emergency, with no time for reference or advice; he must decide at once to save the ship entrusted to him from loss or injury. Furthermore, the occupation of an engineer is not peculiar to the naval service. He takes employment in the navy as he might take employment in a steamship line, or with any other private firm. The line offers a career, while the engineer corps does not. A line officer rises, however slowly, to positions of dignity and trust, and enjoys all the social and official considerations which pertain to them. The engineer at sea begins and ends in the engine-room and never enjoys those gracious advantages to the same extent."

When one considers that the line officers and engineers are educated together at the Naval Academy, taking the same military drills and largely the same course of studies, one can understand why such theories as the above carried into practice should tend to drive every engineer out of the service. The engineers very properly feel that they have the same interest in the country and the flag as other officers, that the emergencies below decks are far more frequent than those above decks. The record of broken shafts is a long one and the detentions at sea from accidents to machinery are familiar to all. The judgment and skill which prevent accident, or deal with a break when it occurs, are fully equal to those required on the bridge in steering a ship. So far as the emergencies in action are concerned, there is little to choose between the gun deck and the fire room. No part of a man-of-war in action can be said to be safe. Even the chaplain may suffer the same fate as a combatant. Little needs to be said on the subject of a naval engineer's career when we consider that the speed of our ships is one of their chief glories. Almost all the machinery which produces this speed is designed by the naval engineer. If he has no career in the navy so much the worse for the service and our country.

Fortunately for the country, Mr. Staunton's theories do not prevail throughout even the line of the navy. The social relations on board ship are usually harmonious, and affectionate memories between line and staff often survive long after a cruise of three years. There is, however, a lack of uniformity in methods on our ships which tends to reduce efficiency. In some cases, the hands of the engineer are so tied by absurd regulations, especially

in the control of his men, that the engineer's force is disorganized; in other cases there is an exercise of good sense which transcends even the naval regulations. The boilers, which form the vital part of a ship, usually suffer most from the lack of co-operation. They are often treated like mere salt water tanks. The interference in mechanical matters by men of no mechanical training would not be tolerated in the merchant service. If, as is fairly claimed, the exigencies of the naval service make it necessary that the commanding officer should have entire control over everything in a ship, including machinery, his education should begin as an engineer, so that that control may at least be intelligent. As a matter of fact, the only men on board of merchant and naval steamers who under modern conditions cannot be spared are the engineers; for without the power to go, our ships would become the playthings of the waves and of no more use in coast defence than derelicts.

The only logical outcome of the present condition of the navy, where the engineers have too few men to enable the ships to run full speed after an enemy and the deck force too few to fight him after catching him, is to fuse the two forces into a homogeneous body of men, so that the greater part of the crew may work at the engines when steaming and at the guns when fighting. This would have come about long ago but for the steady determination that the engineer should have no part in the military organization. He has to-day only what has been yielded to him because of absolute necessity.

Several bills have been introduced into Congress for the improvement of the *personnel*. One of these deals with the engineer corps. It provides for an increase in numbers, for definite military rank instead of the present assimilated rank, for a better definition of command over the engineer's forces, for placing the design and management of all machinery under a Bureau of Engineering, which is to take the place of the present Bureau of Steam Engineering, and finally for making appointments from the enlisted force and from civil life to the Engineer Corps of the Navy. This last feature of the bill may prove of immense importance to the country in founding a great engineering reserve, as it provides for taking on board our ships every year a number of graduates from Technical Schools. They are expected to serve two years, and then to stand a competitive examination for commissions in the

navy. As only existing vacancies are to be filled, the great majority of them would at the end of two years be mustered out of the service and become members of a national reserve. This seems to be the true way to form a naval reserve, by beginning with the schools. There is safety in numbers and the more our people understand about the technical details of naval and military affairs without actually being members of an organization permanently under arms, the more certain will be our defence, and that, too, without the dangers to civil liberties attendant upon great standing armies and huge navies. There is another side to the question, in the great benefit to our Scientific Schools in the uniformity of method that would follow. A yearly examination set by the officers of the government, or a commission of scientific men, would form a standard toward which all could strive. The system would pay a hundred fold simply as an investment for the industries of our country. In these days of keen competition it might add materially to our success in trade with foreign countries by lifting the standards of schools, thus giving the young men entering our shops better preliminary training. Many private institutions could supply graduates well equipped for the duties on board ship. They would lack the military setting up obtained at the Naval Academy, but they would have in compensation a broader and more liberal education. There would be little difficulty in adding to the Scientific Schools instruction in Marine Engineering, particularly on the seaboard. One good effect would inevitable follow from bringing the schools into closer contact with the navy. The people all over the country would take a greater interest in our ships and also in the growth of a merchant marine.

IRA N. HOLLIS.

IV

I AM asked to write on the engineer in naval warfare; on repairs to war vessels during the progress of war and immediately after; on the means of securing speed in repairs to steam war vessels in time of war, and on the desirability of having the great engine-building shops of the country, especially those near the seaboard, the great lakes, and the Mississippi, converted into auxiliary naval repair stations in war time.

No more important subject could be presented to the serious

thought of our countrymen. A valuable service to the nation is being rendered by this REVIEW in dispelling the apathy so generally manifest, and in helping to clear away the dense ignorance of the great mass of American citizens on this subject, which should receive the serious consideration of the Navy Department and of the Congress. In order to fit engineers for the onerous and responsible positions they will be obliged to assume, it will be necessary not only to increase their education, but it will also be necessary to open new and subordinate schools for their preparatory education. Departments of steam and naval engineering should be provided for by the government and the States in all the various State colleges organized under the Hatch act.

The Squire-Wilson bill now before Congress, to increase the usefulness and numbers of the Corps of Naval Engineers, and to establish an experimental station for the investigation of problems connected with naval construction and engineering, is a move in the right direction and should become law.

As Professor Hollis, himself for many years an engineer in our navy, says: "It is directly in line with a fuller recognition of engineering as a profession worthy of the respect and rewards due from a great nation whose material prosperity and industrial growth have been made possible by the engineer."

In addition to this, the act relating to the Naval Reserve Corps should be made more thorough by an amendment providing for the enrollment of engineers and machinists in each State or district. In case of emergency, our navy would thus be provided with the means of calling into service those who would be needed, and of putting the right men in the right places, to serve while needed by their country. The crisis passed, they could return to civil life and to the practice of their calling in the various private manufacturing establishments and machine shops where they are now efficiently at work.

From the graduates of young engineers in these departments, after they have taken their college degree, picked men should be sent to a naval college of applied engineering, or to such a department in our naval college where these young men should not only receive a finished technical education as sailors, but also as engineers of the first rank, in all the various fields of engineering, and they should also receive there the benefits of a liberal education, such as is already provided by the government

at West Point and Annapolis. Such graduates as these would soon scatter forever the common prejudice felt by officers of the line against the engineering department.

It is easy to see that from the class of engineers thus created, and especially from the young men thus at work in the various State colleges, in addition to the body of engineers already in existence and those training with the same end in view at the various technological schools, we should be providing the brains that will be able to repair war vessels in time of war.

From the results of the naval battle at the Yalu, between the Japanese and the Chinese, we have learned that in future sea battles great havoc will be wrought to both fleets. That force which can the soonest repair the damages of such a contest can strike a blow upon its antagonist while still in a disabled condition. It is clear that such a power will in the end conquer.

Thus we see that besides possessing the strongest battle-ships we must also be in a position to repair damages the first. Not having the powerful navy of the English, we are all the more dependent for final success upon our facility in repairing damages during action and immediately thereafter. To do this we must provide the necessary plants, and also the means of setting such plants in immediate operation.

The exigencies of modern war are recognized to be such that speed in such repairs at such a time must be secured at whatever cost. In order that we may then use speed, the right conditions must be prepared beforehand. We should begin by selecting a landlocked bay, capable of protection from the enemy at its mouth; of course with deep water and, necessarily, in that part of the country where mechanical skill is accessible. Several such sites should be chosen on both sides of our mighty continent, on the Mississippi River, and on the great lakes. Owing to the absence of harbors on our Pacific coast, and the difficulty of procuring coal, it would be almost impossible to blockade it. It is also beyond the reach of European countries, and we may, therefore, address ourselves more particularly to the question of naval warfare on the Atlantic coast and Gulf coast. Narragansett Bay, as one site, fulfils these conditions. Its mouth could easily be defended against entrance by the enemy's fleet. Our entire navy, if necessary, could ride securely upon its waters, while it is di-

rectly and immediately connected by inland communication with every centre of mechanical industry on the Eastern coast, to say nothing of the mechanical ability and the manufacturing facilities of Rhode Island itself.

On this coast we find only five navy yards with repair plants. These are Portsmouth, Boston, Brooklyn, League Island, and Norfolk. The poor management and bad policy of our government has allowed the plants at Portsmouth, Boston, and League Island to become so obsolete that repairs to modern ironclads could not be made without remodelling these establishments throughout. This leaves but two navy yards for repairs in case of emergency, Norfolk and Brooklyn. In time of emergency there would be no reserve artisans within easy reach of Norfolk, except those in the shipbuilding plant at Newport News, built as a necessity for a great railroad system. Therefore, the capability of this yard for the expeditious repairs of disabled cruisers is very limited. Navy yards should be located near great manufacturing cities where thousands of mechanics can be gathered for an emergency at short notice. If the Navy Department had listened to engineers, the plant at League Island might have been made an excellent repair station. The location is unexcelled, but the tools are not there. Indeed, it is said that there is now an efficient corps of watchmen on duty in this yard to keep interlopers from going over the neglected buildings.

Having thus provided both the brains and the hands necessary to carry on repairs during naval warfare and immediately after a battle, there remains one essential step necessary—to give the President of the United States, as commander-in-chief of the navy, the power to make these resources available beyond peradventure. Although the patriotism of the owners of shipyards and manufacturing establishments is unquestionable, in time of war and under pressing necessity we should not be dependent upon their voluntary action. Power should be vested in the President, in time of war, acting under the advice and consent, perhaps, of his cabinet, under the exercise of eminent domain, to condemn and take for public use whatever manufacturing establishments may be necessary to carry into instant effect the proposed system for immediate naval construction and repairs. Of course, under the provisions of the constitution, the rights of the owners will be amply protected, for they must be paid the full

value of their property thus taken for public use, and in case of disagreement as to this value, it must be fixed by a jury trial.

In addition to these measures intended to provide for immediate repairs, our fleet should also be furnished with floating workshops or repair-ships. In case of emergency they could be manned by members of the proposed Naval Reserve Corps; for in this fine body of men will be found many skilful artisans. It is not intended that these repair-ships should be floating dockyards, but they should be so equipped as to be capable of being laid by the side of any vessel needing repairs, not of such a nature as to require her to go into a dock, but still of such a nature as to require assistance outside of the vessel herself. For instance, it may be necessary after a battle, or an extended cruise, to make general repairs, the result of injuries from forced duty. With such a repair-shop as above indicated, alongside of the cruiser, with the necessary power transmitted directly, these repairs could be immediately and efficiently completed.

It seems hardly necessary to add that in case of a great naval battle at the present day between great rival war vessels entirely dependent upon machinery and steam for propulsion, it would be necessary to provide powerful, fast tugboats, ready at any moment to lie alongside of a disabled vessel to tow her out of danger or into a harbor of refuge, when directed so to do by the admiral in command.

Recent international events, as well as the necessity of protection to our commerce, prove unmistakably that our peace and dignity as a nation can be best preserved and maintained by an efficient navy. Such a navy is also necessary to make ourselves felt in the councils of the great powers when a canal, constructed and controlled by our own government, shall connect and control the Atlantic and Pacific oceans. The important question of building up a good navy, and then of its maintenance in proper condition, has not been adequately considered in our Congress. It is manifest, however, that we have not the means for building modern cruisers, for keeping them in repair, and for repairing them after damage in battle, in any of our national navy yards; nor are these yards properly protected from injury by the enemy in case of war. They are still looked upon as the sport and prey of political intrigue.

The manner of carrying on business by our government in

these navy yards is not in accordance with modern business and industrial methods. Official routine and red tape, combined with want of proper business methods, cause such delay that, where time is an object, government navy yards cannot compete with outside firms. It is to private firms, therefore, that we must look for relief in time of emergency. We are fortunate in having many industrial establishments, not only upon the coast, but in inland cities within easy reach of deep water, whose plants could be readily adapted to the work and where the repairs would be quickly carried on. Thanks to these engineering establishments and to the genius and ability of the engineers of our country, we can quickly produce any required war material and we can quickly make any necessary repairs in case of injury arising in battle or otherwise. It is to them and to the naval and mechanical engineers we must turn for relief, both before the battle and after the battle. These engineers and the machinists and artisans who under their direction prepare the modern warships for battle, maintain the numerous engines in efficiency during action, and repair damages after the conflict, will be the men through whom success must be largely secured.

It is fortunate we have excellent private machine shops and yards scattered along our seaboard States. Here, again, the pre-eminence of Narragansett Bay is manifest, for it is here we find many of the most skilful mechanics in the country, and manufacturing establishments with various departments under the management of men who rendered valuable engineering services to the country during its last war. On its shores and in Providence any repairs needed for the navy can be speedily done. At Bristol the world-famous establishment of the Herreshoffs, in any emergency, stands ready to devote its services to anything our navy may call for. The Taunton shops are near by. Worcester is but forty-four miles off, up the valley of the Blackstone, and along the whole distance, the traveller is never out of the sound of factory bells, marking the sites where, in case of emergency, the government would find trained engineers and machinists ready to serve their country.

The pre-eminence of Narragansett Bay as a site for our merchant marine, and for the landing of passengers and freight from Europe for distribution throughout the country, has never yet been sufficiently recognized. Between Wickford and Whale

Rock lies a natural harbor where passengers and freight can easily be landed within two hours of Boston and within three hours of New York. Both this harbor and the eastern passage between Newport and Tiverton are directly accessible to ocean steamers, thus avoiding the intricate channel of Boston, that has so seriously handicapped her as a port. Were these natural facilities taken advantage of by the establishment of suitable wharves, docks, and repair shops for our merchant marine, in time of peace, they would be directly available for use by our government for naval repairs in case of war.

In every-day life, common sense teaches us when we want anything done to go to a man who makes that thing his business, but matters are managed differently in the United States Navy. At the head of a navy yard is a line officer who has been taught seamanship, but who, unless he is also an engineer, has no knowledge of what is necessary to be done to repair condensers, pumps, or separators, and miles of piping, disabled engines, or boilers. This is certainly wrong, and, from a business point of view, a marine engineer of recognized ability should be made director of repairs. Such a man should possess great physical powers, for the work would be of severe character. He should be in touch with men of his profession, and he should be known to have progressive ideas. He should also possess knowledge of the ships and of their machinery. Such a man could call upon the heads of the great manufacturing establishments in this country for assistance in time of emergency. He could learn beforehand what kind and number of men each establishment could furnish him, and also what repairs each establishment could undertake. The patterns for parts that might require duplication should be distributed among these establishments. Just as the great engine manufactories in this country now build their engines, in duplicate interchangeable parts, many at a time, thus reducing cost, so should our government build vessels in duplicate, thus reducing their cost. This system would prove of great service whenever repairs became necessary. Such a director of repairs, with assistance at each repair station, would bring the system into business order.

Trained inspectors should also be supplied to test all construction and repairs, and to pass upon the acceptance or rejection of material. These men should be engineers. Under the present

policy of the Navy Department, officers of the line are sent to do this work. Many of them are not familiar with the various metals and alloys used, and, in many cases, having had no training as engineers, they cannot understand machinery specifications. The inevitable result is, that both the government and the naval constructor suffer from this system.

It is easy to see that the engineer will play a more important part in naval warfare, and, unless this is recognized, we shall lose in large measure the good we may otherwise derive from our warships. The weapon has changed from the catapult and spear of the galley, propelled by oars, through the matchlock and smooth bore of the sailing frigate, to the battle-ship of the present day—a huge fighting machine whose soul is steam power. A new weapon has come and with it must come a change in the organization of the navy. The naval engineer must be given the standing to which he is justly entitled. Being responsible for repairs on board ship, he must have control over the men who make them. He can only succeed in the prevention of derangement by having the power to supervise all machinery on board the vessel. Next to the commanding officer, the engineer on a modern warship is the most important officer, taking into consideration the duties he has to perform. He and his assistants must, therefore, be given the rank and title that are their due.

We cross the Atlantic Ocean on some magnificent English steamship and learn that both ship and officers are liable to instant call to serve as auxiliaries to the English navy, in case of war. What similar resource have we? Will it do for us longer to remain supinely indifferent, trusting to luck should war come suddenly upon us? It is only in the cases of the last two merchant ships, the St. Paul and St. Louis, we have followed this example.

By the terms of the existing treaty with England, each country is limited to one gunboat on the great lakes. But England keeps in constant readiness, in case of war with us, four gunboats that could reach the lakes through Canadian canals and waterways. Once upon these lakes, before we could build gunboats to meet them, they would control the lakes, every city upon them, and the railroads from the West passing by the lake shores. What measures have we provided to anticipate this possibility?

The purpose of my few words will be met, if through them I can help in arousing our country to some sense of its present naval inferiority and the means to be adopted to remedy it. To this end nothing will contribute more than the recognition of the importance of the steam engineer in modern warfare. Through him is to be supplied the essential to success in the modern navy—power. Already have we more than doubled the steam horse power of the world in the past seven years. That great man, Gladstone, but voices the recognition of our services when he characterizes steam as an agent that has revolutionized the world. When George III. asked Watt what he had, his answer was prophetic: "I have what every subject of your Majesty wants—Power."

GARDINER C. SIMS.

V.

THE registered and licensed tonnage of our merchant marine comprises 6,919 steam vessels, on which serve 21,006 licensed masters, mates, and pilots, with 17,530 engineers for duties relating to the motive power. In our navy, before the ending of the Civil War, there were 2,463 deck officers and 2,279 engineers. It will be seen that, with the business methods of the merchant service in peace, and for the needs of the navy in warfare, the number of officers below decks is nearly equal to that doing duty above.

The entire force of merchant engineers as given above would not be available in the event of war. Of the ships noted, 4,000 are under 200 tons in size, and are also of such construction that but few of them could be adapted for war purposes. On these steamers there are 8,000 engineers whose licenses do not permit them to take charge of a watch on a sea-going vessel. We have remaining then about 2,500 steamers with 9,000 engineers. While we have no official physical examinations, it is safe to say that, of the latter number, at least one-sixth would be debarred, by constitutional impairments or by injuries received in line of duty, from entering the naval service, which receives only men in perfect health. This would leave, as possibilities for war requirements, a force of about 7,500 licensed engineers.

During the year 1864, the time of its maximum strength, the regularly commissioned navy consisted of about 600 vessels, in-

cluding about 100 on the western rivers. In addition to these, the Quartermaster's Department of the Army built, purchased, chartered, or otherwise employed about 650 steamers of over 150 tons' measurement; and the other military departments had undoubtedly in their service 150 more vessels of such size. We have, then, an approximate total of 1,400 steamers used by the Northern forces for guarding but a part of our coast-line and for furnishing supplies to the armies. If we should have, in the future, both coasts and the lakes to defend, as well as several armies on the Canadian frontier to supply, it would be but a moderate estimate which would give us 2,500 steamers for all war-purposes.

In the construction, repair and maintenance of so large a fleet as this, the engineers of the merchant marine would have a work which would occupy fully their whole available force. It is not to be supposed, however, that our coasting trade would be completely paralyzed; and, further, war would stimulate, not depress, business on the rivers and a part of the lakes, so that the commercial demand for engineers in these localities would be increased rather than lessened. Again, a great number of our engineers are attached to river boats, and would therefore be likely, if they volunteered, to connect themselves with the military, and not the naval, service. With these facts in view, it is evident not only that the entire available force of merchant engineers would not be employed on war duty, but that also they could, least of all, be depended upon to fill vacant places in the warships of the navy.

A further point must be considered in connection with the presumed availability of our engineers for duty on war-vessels. Although they see and know more of these ships than any other class of our citizens, they are the last to enter the naval service. Despite the substantial pension and other benefits which should result from such a course, with the opportunity for extended foreign travel, the records of our organization show that very few ever enlist in the navy. Its whole system is distasteful to them, founded as it is on the tradition of the past and exalting as it does one class of officers unduly, while it minimizes the importance of the engineer. There has been, and is, an urgent demand for machinists on our warships and the younger members of our organization would doubtless be welcomed, if they cared

to enter this service. This, however, they will not do and the navy has been compelled, therefore, to secure machinists from the industrial plants—young men who have never been to sea, and who are ignorant of the humiliation and persecution awaiting them. Even these are not always available, and, in some cases, firemen and oilers, who are not mechanics, are, through necessity, advanced to the machinist-rating. Yet, we hear constantly, that, in time of emergency, the engineers of the merchant marine will seek these difficult and dangerous positions, which, in times of peace, have no attraction for them. Very little is said as to the readiness of the masters, pilots, and mates to take the places of the captains and lieutenants of the navy, although they are far better fitted to command the vessels of the transport-service than are the latter officers. A competent commander can be developed in a less time than is required to train a chief engineer; and yet an excess of deck officers is maintained for unexpected emergencies in the navy, while no provision is made for the sudden needs of the engine-room.

Our merchant vessels are not over-crowded with engineers; there are too few rather than too many; and there will surely be no over-sufficiency when, with war, the work grows harder. There are hundreds of tug-boats running with but a single engineer, and official records show that it is not unusual for one of these men to remain continuously in the engine-room for over twenty-four hours, sleeping only when the engines are stopped. There are, in addition, other confirmatory facts which prove that there is an insufficient number of engineers to care properly for the machinery of the merchant marine. The evil of the excessive period of continuous duty above referred to, has been considered by our association, which proposes that it shall be corrected.

We recognize fully that the Corps of Naval Engineers must have a military and scientific training in order to direct the large engine and fireroom forces which are under their control, and to design, construct, maintain, and supervise the working of the numerous and complicated engines, for many varied purposes, which are placed in their charge, and which, for important military reasons, are crowded into unusually contracted spaces on war vessels. It requires special training of a high order for such work; it has cost the government at least $15,000 to educate

each of these officers, and it would be surprising if they did not possess special attainments. Our own sphere of duty is, as well, a broad and honorable one in peace; and if, in warfare, we shall maintain the machinery of the great transports and privateers in a state of efficiency, we shall do a military work of the highest importance, for the value of a modern fleet will be determined, in a great measure, by the proper service of its auxiliary vessels.

If, despite the facts which have been presented, it is still assumed that our members will, in war, enter the naval service, it seems pertinent to inquire where the trained men shall be found to fill the places they leave vacant. The man who does not know presumes to tell us that the locomotive engineer will be transferred to the ships of the mercantile marine. Will railroads stop running in time of war? Will not their traffic be increased rather than diminished? The men composing the Locomotive Brotherhood possess qualities which make them, as an organization, respected and feared. They must be of strong physique, quick of judgment, fearless in danger, and with all the attributes innate with men of sturdy mental fibre and of good moral character. The locomotive driver is undoubtedly at the head of the artisan classes, but it is not always requisite that he shall have a trade. It has been repeatedly stated in print by leading officials of great railway companies that, in many cases, their engineers are forbidden to carry any but the simplest tools. It is not expected that they shall make repairs, since all overhauling of the parts is done at the terminal stations. On the other hand, the necessities of the merchant service require that those in charge of the engines shall be able not only to manipulate but to repair them. It is apparent, then, that only on a few ships, with simple engines, can the Locomotive Brotherhood relieve marine engineers. That this should be so is not a reflection upon the former; it is but seldom that skilled workers of any class can replace others whose vocation differs from theirs in character.

The only man who seems unaware of these and other existing engineering conditions, within and without his service, is the sailor officer of the American navy. Since he has possessed for a century nearly all of its emoluments and honors, the reform of the naval organization will never take place with his approval; it must come from the Congress.

The distinguished engineer-in-chief of the navy is not only a

friend, but an honorary member, of our organization. For years, Commodore Melville has studied the problem as to the most effective use of our force in war, and our executive officers have conferred with him repeatedly in regard to it. There can be no better man than he, with his years of experience and his wide knowledge, to suggest a measure which shall utilize for the national defence the service of the Marine Engineers' Association, a body which is powerful both in number and influence. The full measure of its patriotism and of its regard for law and order has been signally shown on more than one occasion. The maritime bodies of Chicago know that it was the conservatism of the marine engineers which prevented the great strike of 1894 from being a success, and which saved that municipality from being turned over to riot. It is needless to state the inducements which were then offered our members to desert their ships and paralyze the trade of that port. Our organization has never attempted a strike. In the conflict between capital and labor, the marine engineers have invariably won. Nearly all of our people have trades; and, if it shall ever be necessary for them to leave their ships, they can earn a living elsewhere and prolong the contest indefinitely.

The tradition and conservatism of the sailor have retarded the development of our naval strength, not only afloat but ashore. The force of the Naval Reserve, as officially stated, is something less than 5,000 men. The rosters of the organizations of the various States show that but three engineer officers have been authorized in the entire complement; and yet the Naval Militia receives national bounty and is under the control of the Navy Department. If these facts were fully known, the national appropriation for this purpose would be imperilled. A naval reserve cannot be efficient which fails to recognize the engineer as an integral part of its force. If, in peace, we are denied entrance to this body, wherein are we fitted for usefulness in war?

The most pressing naval problem is that of providing for the great and sudden expansion of the work of the Corps of Naval Engineers in time of emergency. As with the worthless designs for machinery purchased in England for our navy by officers who were not engineers, so signal failure has resulted always from the attempt of others to do the work of naval engineers, and yet there are too few of the latter in our service. They have been crowded out of our warships to make room for an excess of deck

officers. Our organization now realizes the power which it possesses. We propose that the Congress, and not the regulations prepared by a few sailors, shall settle the question as to how we shall co-operate with naval engineers. This is under discussion by the 100 local associations which compose our membership.

There should be extended to the navy the system of the merchant marine which gives engineers immunity from the interference of mates on deck. The directors of our corporations find this necessary. With this system in the navy we should hear no longer the complaints as to the unsatisfactory organizations of our war-ships.

There is now before the Congress a measure demanding that none but Americans be placed in the engine-rooms of our naval vessels. This precaution is the due not only of patriotism, but of wisdom, since, when urgent need shall come for these ships, their machinery, at least, will not be manipulated by aliens. In this connection it may be said that, while all steamship lines receiving subsidies assumed in a measure reciprocal responsibilities to the nation, those companies which have been the greatest beneficiaries of this government gratuity are the least inclined to employ American marine engineers.

Of the several bills which have been introduced for the reorganization of the *personnel* of the navy, there is none so important for the efficiency of the service, none so patriotic in its purpose and scope, none so worthy of the nation's knowledge and approval, as the Wilson-Squire Engineering and Educational Bill. From the standpoint of our organization, it is the greatest naval measure which has ever been presented to a Congress of the United States.

As a supplement to this, the Squire–Hopkins Bill, whose object is the increased efficiency of the engineer service of the merchant marine, will add materially to the usefulness of the transports and other auxiliary vessels.

A change is imperative in the organization of our naval service. The Corps of Engineers must receive the recognition which its importance demands. With this change, the mechanical and scientific branch of the navy will offer inducements sufficient to attract the engineers of the merchant marine.

GEORGE UHLER.